

PATENT ABSTRACTS OF JAPAN

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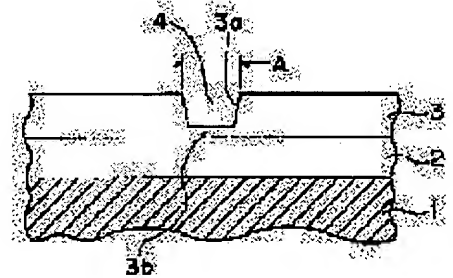
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(54) METHOD FOR FORMING RESIST PATTERN

(57)Abstract:

PURPOSE: To form an opening with a given width accurately in a resist layer on a silicon nitride film.

CONSTITUTION: An ultraviolet ray with a wavelength of 180 to 220nm is cast to a surface of a silicon nitride film 2 to reform the film surface. After a resist 3 having a carboxyl group as a side chain is applied and the silicon nitride film 2 is baked, an electron-beam drawing process is carried out to form an opening 4 with a given width in the resist 3. In this case, since an ultraviolet ray is cast, no residue 3b remains in the resist.



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CLAIMS

[Claim(s)]

[Claim 1] The resist pattern formation method characterized by irradiating the wavelength of 180nm, or 220nm ultraviolet rays on the front face of the above-mentioned silicon nitride film before applying the above-mentioned resist in the resist pattern formation method which performs an electron beam lithography and forms opening of a predetermined size in the above-mentioned resist, after applying the resist which has a carboxyl group in a side chain on the surface of a silicon nitride film and performing BEKU.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] This invention relates to the method of forming opening of a predetermined size in the resist applied on the silicon nitride film in more detail about the resist pattern formation method.

[0002]

[Description of the Prior Art] In recent years, as a resist which has sensitivity to an electron ray, the resist which has a carboxyl group in a side chain is developed variously, and is used for micro processing in the semiconductor process. For example, as shown in drawing 1, in order to process the silicon nitride film 2 deposited on the GaAs substrate 1, the resist which has this kind of carboxyl group in a side chain may be used as a mask. In the example of the methacrylic-acid phenyl copolymer resist 3, first, on a silicon nitride film 2, a spin coater is used and the above-mentioned resist 3 is applied to the thickness of 1500A. Then, after giving BEKU of 2 hours at the temperature of 230 degrees C (150 degrees C or more are required), a pattern with a line breadth of 1500A is drawn by the electron beam lithography. Next, negatives are developed using the mixed liquor of a methyl-isobutyl-ketone-ethyl cyclohexanol (80:20), and opening 4 is formed in the above-mentioned resist 3. Here, since residue 3b of the resist 3 with a thickness of 250-300A arises at the bottom of opening 4, oxygen plasma removes resist residue 3b. Then, by using a resist 3 as a mask, by ****-ized hydrogen solution etc., it *****s and the above-mentioned silicon nitride film 2 is patternized.

[0003]

[Problem(s) to be Solved by the Invention] By the way, considerable-amount etching of the side-attachment-wall 3a of opening 4 is carried out at the same time it is difficult to give an anisotropy to etching and it *****s resist residue 3b, when *****ing resist residue 3b by oxygen plasma. In the example described above, since oxygen plasma is performing 250-300A etching, there is a problem that the width of face (line breadth) A of the longitudinal direction of opening 4 increases greatly (about 500-600A). Moreover, since etching of the resist by oxygen plasma cannot be performed with sufficient repeatability on the level of hundreds of A (there should be just few amounts of etching.), the precision of line breadth A falls.

[0004] In addition, although how to decrease the amount of etching of side-attachment-wall 3a of opening 4 by carrying out anisotropic etching of the resist by reactive ion etching (RIE) can be considered, it is not desirable when a shallow channel layer is directly under opening 4. It is because it must heat-treat separately in order that a channel layer may receive a damage and may recover a damage.

[0005] Then, the purpose of this invention is to offer the resist pattern formation method which can form resist opening of a predetermined size with a sufficient precision on a silicon nitride film.

[0006]

[Means for Solving the Problem and its Function] In order to attain the above-mentioned purpose, this invention is characterized by irradiating the wavelength of 180nm, or 220nm ultraviolet rays on the front face of the above-mentioned silicon nitride film, before applying the above-mentioned resist in the resist pattern formation method which performs an electron beam lithography and forms opening of a predetermined size in the above-mentioned resist after applying the resist which has a carboxyl group in a side chain on the surface of a silicon nitride film and performing BEKU.

[0007] This invention was created by the next experiment by this invention person, and consideration. After this invention person applied the above-mentioned resist on the surface of the silicon nitride film and performed BEKU at predetermined temperature, he was flooded with the acetone which is a good solvent in the above-mentioned resist. Although the above-mentioned resist should be completely dissolved properly speaking, the resist residue with a thickness of about 220A arose on the surface of the silicon nitride film in fact. This cause is because it is in the state where the imino group on the front face of a silicon nitride film and the amino group join together strongly by a carboxyl group, dehydration, etc. in a resist, and the resist of an interface does not dissolve. Therefore, before applying the above-mentioned resist, generating of a resist residue can be suppressed by irradiating ultraviolet rays and reforming them on the front face of the above-mentioned silicon nitride film. Therefore, etching [of the resist residue by oxygen plasma] becomes unnecessary, or it can be small and resist opening of settled and a predetermined size can be formed now with a sufficient precision.

[0008]

[Example] Hereafter, an example explains the resist pattern formation method of this invention in detail. In addition, suppose that a methacrylic-acid-methacrylic-acid phenyl copolymer resist is used as a resist which has a carboxyl group in a side chain.

[0009] First, a silicon nitride film 2 is deposited on the front face of the GaAs substrate 1 the same with having been shown in drawing 1 (since it is easy, it explains using the same sign.). Then, ultraviolet rays with a wavelength of 180-220nm were irradiated at optical on-the-strength 0.66mW/cm² and the room temperature on the front face of this silicon nitride film 2 for 1.5 hours. When the infrared absorption spectrum of the above-mentioned silicon nitride film 2 was measured before and after this UV irradiation processing, the absorption of 1100-1200cm⁻¹ by N-H (bend) observed before UV irradiation was decreasing sharply after UV irradiation. That is, UV irradiation showed that the imino group of silicon-nitride-film 2 front face and the amino group were decreasing. Then, on the above-mentioned silicon nitride film 2, the spin coater was used and the above-mentioned resist (in detail 74.6 mol methyl [% and 5 % of the weight] Cellosolve acetate solution of 25.4 mol % and methacrylic-acid phenyl components of methacrylic-acid components) 3 was applied to the thickness of 1500A. Then, BEKU of 1 hour was given at the temperature of 230 degrees C (150 degrees C or more are

required), and the line pattern of 3 nC/cm was drawn with electron-beam-lithography equipment. Next, negatives were developed using the mixed liquor of a methyl-isobutyl-ketone-ethyl cyclohexanol (80:20), and opening 4 was formed in the above-mentioned resist 3. Here, only 80A *****ed resist residue 3b by oxygen plasma. Then, by using a resist 3 as a mask, by ****-ized hydrogen solution, at the bottom of etching of the above-mentioned silicon nitride film 2, and the time, precision was able to improve pattern processing as it drew by the electron ray. Thereby, resist residue 3b has checked indirectly that the imino group of silicon-nitride-film 2 front face and the amino group combined with the carboxyl group in a resist 3, and arise. Then, 2000A only in thickness deposited metal aluminum by using a resist 3 as a mask on the above-mentioned GaAs substrate 1. This formed the aluminum electrode of 0.15-micrometer line breadth on the GaAs substrate.

[0010] On the other hand, in what did not perform the above-mentioned UV irradiation processing, but performed the process after resist 3 application on the non-processed silicon nitride film 2, when the amount of etching of resist residue 3b by oxygen plasma was 200A or less, the part where a silicon nitride film 2 does not ***** at all, or it does not ***** on a partial target remained. It is because resist residue 3b was not able to be removed. When the amount of etching of resist residue 3b by oxygen plasma is made into 200A, finally the line breadth of an aluminum electrode has increased to 0.2 micrometers.

[0011] In addition, after BEKU [this invention person / the silicon-nitride-film 2 above-mentioned front face / the resist 3 / applied and], the amount of resist residue 3b when flooding with an acetone (good solvent) in front of an electron beam lithography observed changing according to UV irradiation time, as shown in Table 1. That is, to the thickness of resist residue 3b becoming 220A when not performing UV irradiation, when UV irradiation time was made into 10 minutes, 30 minutes, and 90 minutes at a room temperature, the thickness of resist residue 3b found 190A, 145A, 80A, and the bird clapper. Thereby, this effect of the invention was able to be checked quantitatively.

[Table 1]

紫外線照射時間	レジスト残渣の膜厚
なし	2 2 0 Å
室温 1 0 分	1 9 0 Å
室温 3 0 分	1 4 5 Å
室温 9 0 分	8 0 Å

[0012]

[Effect of the Invention] As mentioned above, since ultraviolet rays (the wavelength of 180nm or 220nm) are irradiated on the front face of the above-mentioned silicon nitride film before applying the above-mentioned resist, when performing the electron beam lithography after applying the resist to which, as for this invention, the resist pattern formation method has a carboxyl group in a side chain on the surface of a silicon nitride film so that clearly and performing BEKU and forming opening of a predetermined size in the above-mentioned resist, resist opening of a predetermined size can be formed with a sufficient precision on a silicon nitride film.

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TECHNICAL FIELD

[Industrial Application] This invention relates to the method of forming opening of a predetermined size in the resist applied on the silicon nitride film in more detail about the resist pattern formation method.

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EFFECT OF THE INVENTION

[Effect of the Invention] As mentioned above, this invention is the resist pattern formation method so that clearly. Since the wavelength of 180nm or 220nm ultraviolet rays is irradiated on the front face of the above-mentioned silicon nitride film before applying the above-mentioned resist when performing an electron beam lithography and forming opening of a predetermined size in the above-mentioned resist after applying the resist which has a carboxyl group in a side chain on the surface of a silicon nitride film and performing BEKU, resist opening of a predetermined size can be formed with a sufficient precision on a silicon nitride film.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] By the way, considerable-amount etching of the side-attachment-wall 3a of opening 4 is carried out at the same time it is difficult to give an anisotropy to etching and it *****s resist residue 3b, when *****ing resist residue 3b by oxygen plasma. In the example described above, since oxygen plasma is performing 250-300A etching, there is a problem that the width of face (line breadth) A of the longitudinal direction of opening 4 increases greatly (about 500-600A). Moreover, since etching of the resist by oxygen plasma cannot be performed with sufficient repeatability on the level of hundreds of A (there should be just few amounts of etching.), the precision of line breadth A falls.

[0004] In addition, although how to decrease the amount of etching of side-attachment-wall 3a of opening 4 by carrying out anisotropic etching of the resist by reactive ion etching (RIE) can be considered, it is not desirable when a shallow channel layer is directly under opening 4. It is because it must heat-treat separately in order that a channel layer may receive a damage and may recover a damage.

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OPERATION

[Means for Solving the Problem and its Function] In order to attain the above-mentioned purpose. Before this invention applies the above-mentioned resist in the resist pattern formation method which performs an electron beam lithography and forms opening of a predetermined size in the above-mentioned resist after applying the resist which has a carboxyl group in a side chain on the surface of a silicon nitride film and performing BEKU, it is characterized by irradiating the wavelength of 180nm, or 220nm ultraviolet rays on the front face of the above-mentioned silicon nitride film.

[0007] This invention was created by the next experiment by this invention person, and consideration. After this invention person applied the above-mentioned resist on the surface of the silicon nitride film and performed BEKU at predetermined temperature, he was flooded with the acetone which is a good solvent in the above-mentioned resist. Although the above-mentioned resist should be completely dissolved properly speaking, the resist residue with a thickness of about 220A arose on the surface of the silicon nitride film in fact. This cause is because it is in the state where the imino group on the front face of a silicon nitride film and the amino group join together strongly by a carboxyl group, dehydration, etc. in a resist, and the resist of an interface does not dissolve. Therefore, before applying the above-mentioned resist, generating of a resist residue can be suppressed by irradiating ultraviolet rays and reforming them on the front face of the above-mentioned silicon nitride film. Therefore, etching [of the resist residue by oxygen plasma] becomes unnecessary, or it can be small and resist opening of settled and a predetermined size can be formed now with a sufficient precision.

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EXAMPLE

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[0009] First, a silicon nitride film 2 is deposited on the front face of the GaAs substrate 1 the same with having been shown in drawing 1 (since it is easy, it explains using the same sign.). Then, ultraviolet rays with a wavelength of 180-220nm were irradiated at optical on-the-strength 0.66mW/cm² and the room temperature on the front face of this silicon nitride film 2 for 1.5 hours. When the infrared absorption spectrum of the above-mentioned silicon nitride film 2 was measured before and after this UV irradiation-processing, the absorption of 1100-1200cm⁻¹ by N-H (bend) observed before UV irradiation was decreasing sharply after UV irradiation. That is, UV irradiation showed that the imino-group of silicon-nitride-film 2 front face and the amino group were decreasing. Then, on the above-mentioned silicon nitride film 2, the spin coater was used and the above-mentioned resist (in detail 74.6 mol methyl [% and 5 % of the weight] Cellosolve acetate solution of 25.4 mol % and methacrylic-acid phenyl components of methacrylic-acid components) 3 was applied to the thickness of 1500A. Then, BEKU of 1 hour was given at the temperature of 230 degrees C (150 degrees C or more are required), and the line pattern of 3 nC/cm was drawn with electron-beam-lithography equipment. Next, negatives were developed using the mixed-liquor of a methyl-isobutyl-ketone-ethyl cyclohexanol (80:20), and opening 4 was formed in the above-mentioned resist 3. Here, only 80A *****ed resist residue 3b by oxygen plasma. Then, by using a resist-3 as a mask, by ****-ized hydrogen solution, at the bottom of etching of the above-mentioned silicon nitride film 2, and the time, precision was able to improve pattern processing as it drew by the electron ray. Thereby, resist residue-3b has checked indirectly that the imino group of silicon-nitride-film 2 front face and the amino group combined with the carboxyl group in a resist-3; and arise. Then, 2000A only in thickness deposited metal aluminum by using a resist 3 as a mask on the above-mentioned GaAs substrate 1. This formed the aluminum electrode of 0.15-micrometer line breadth on the GaAs substrate.

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[Table 1]

紫外線照射時間	レジスト残渣の膜厚
なし	220 Å
室温 10分	190 Å
室温 30分	145 Å
室温 90分	80 Å

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is drawing showing the state where opening was formed in the resist applied on the surface of the silicon nitride film.

[Description of Notations]

- 1 GaAs Substrate
- 2 Silicon Nitride Film
- 3 Resist Which Has Carboxyl Group in Side Chain
- 3a Resist side attachment wall
- 3b Resist residue
- 4 Opening

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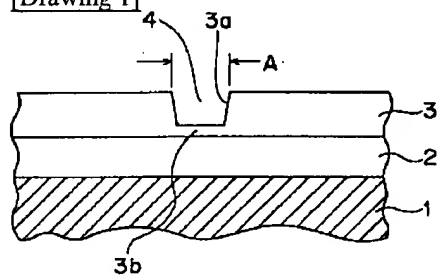
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DRAWINGS

[Drawing 1]



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